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Volume XI
Number 3

MARCH, 1920

$4.00 a Year
60c Per Copy

The Journal of Educational Psychology

Editors

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PUBLISHED MONTHLY, EXCEPT JUNE TO AUGUST BY

WARWICK & YORK, INC.,
HARRISBURG, PA. BALTIMORE, MD.

[Application made for transfer of entry as second-class matter at the post-office at Harrisburg, Pa., under the Act of March 3, 1879.]

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VOLUME XI MARCH, 1920 NUMBER 3

THE JOURNAL OF
EDUCATIONAL PSYCHOLOGY

The Measurement of Ability in Latin—Part III. Vocabulary and Sentence Tests

V. A. C. HENMON

The University of Wisconsin.

In two previous papers,[1] investigations were reported resulting in five standardized vocabulary tests and three sentence tests for measuring progress and ability in Latin. The vocabulary tests were based on 239 words common to thirteen first-year books and to Caesar, Cicero and Vergil. It was pointed out that, in addition to these words, there were 80 other words common to the first-year books, but not found in the vocabularies of all three writers. The sentence tests were derived from 44 sentences containing none but words in the standard list. It was noted in the case of the sentences that some of them did not grade up by uniform steps, that some showed an inversion in the third year, and that it would be necessary to experiment with a much larger number of sentences before an entirely satisfactory sentence scale or test could be constructed.

The present paper supplements the earlier studies by giving scale values for the eighty additional words and for sixty additional sentences.

VOCABULARY TEST

A blank containing the list of eighty words arranged alphabetically was printed and given in fourteen schools distributed in six states. The blank is not reproduced but the list as given appears in Table II below. Table I gives the median number of words correctly translated and the number of pupils in each school and in each year.

The noteworthy features of this table are, as shown in all tests of this character, the wide variations in schools and in pupils. The contrast between School G with a median score of 31 words in the first year and School H with a score of 78 words is especially

[1] Jour. of Educ. Psychology, Nov. and Dec. 1917.

TABLE I—VOCABULARY TEST

SCHOOL	MEDIANS				NUMBER OF PUPILS			
	I	II	III	IV	I	II	III	IV
A	60	65	59	60	44	35	10	4
B	60	64	77	72	13	8	3	
C		66				23		
D	50	53	50	55	44	30	19	11
E	50	55	70	77	27	8	3	3
F	51	59	58	62	44	33	19	9
G	31	52			56	21		
H	78	76	74	74	27	21	14	13
I	55	45	48	56	46	29	6	6
J	46	54	61		19	14	3	1
K	50	58	63	67	13	21	8	11
L	42				5			
M	38	48			18	10		
N			69	68			13	8
	51	59	63	67	356	253	98	72
Range	11–79	14–80	32–79	32–80				

striking. The wide variation among pupils appears in the range, but is indicated more strikingly by the fact that the median score of the upper tenth of the first year is 77 words, while the median of the lower tenth is 25 words. The range from 11 to 79 is not due, therefore, to very exceptional cases. The variability in the second, third, and fourth years is almost as marked as in the first year, and there is the now familiar overlapping of the distribution curves.

The purpose of this study is the determination of the weights or values to be assigned to each word for each year and a general scale value for all four years. Table II gives the essential information for these determinations and the scale values that have been derived.

The method of determining the scale values has been described in detail in the earlier papers. The method in substance consists of locating each word on the base line of a normal surface of frequency in terms of the probable error equivalents of the percentages of times it is correctly translated. This is the first step. In order to eliminate minus values an approximation to a zero point of ability was arbitrarily taken by locating the position of a word so easy that it would be missed by but 5 out of 1000 first year pupils. This point is located 3.8 P. E. below the median. The scale value for each word was then determined by subtracting from or adding to -3.8

TABLE II

	Percents Correct				Scale Values				General Scale Values
	I	II	III	IV	I	II	III	IV	
acriter, ...	47.7	61.7	61.2	62.5	3.9	3.4	3.4	3.3	3.5
agmen, ...	38.5	49.4	45.9	63.8	4.2	3.8	4.0	3.3	3.8
amicitia, ...	62.3	81.8	80.6	81.9	3.3	2.5	2.5	2.4	2.7
animal, ...	91.3	91.3	93.8	94.4	1.8	1.8	1.5	1.4	1.6
bene, ...	79.2	83.0	94.9	100.0	2.6	2.4	1.4	.0	1.6
captivus, ...	82.5	86.6	89.8	84.7	2.4	2.2	1.9	2.3	2.2
celeritas, ...	43.5	59.3	74.5	80.6	4.0	3.5	2.8	2.5	3.2
celeriter, ...	58.4	71.5	74.5	70.8	3.5	3.0	2.8	3.0	3.1
civitas, ...	83.4	76.7	76.5	83.3	2.4	2.7	2.7	2.4	2.6
collis, ...	73.3	92.5	86.7	90.3	2.9	1.7	2.2	1.9	2.2
convoco, ...	60.4	72.3	85.7	73.6	3.4	2.9	2.2	2.9	2.6
cornu, ...	75.8	72.7	74.5	81.9	2.8	2.9	2.8	2.4	2.7
decimus, ...	47.7	57.7	63.2	66.7	3.9	3.5	3.3	3.2	3.5
dissimilis, ...	77.2	80.6	92.8	90.3	2.7	2.5	1.6	1.9	2.2
ducenti, ...	34.8	60.5	43.9	43.1	4.4	3.4	4.0	4.1	4.0
duodecim, ...	76.9	87.7	87.7	83.3	2.7	2.1	2.1	2.4	2.3
equitatus, ...	53.1	74.7	76.5	63.8	3.7	2.8	2.7	3.3	3.1
equus, ...	76.7	89.7	90.8	95.8	2.7	1.9	1.8	1.3	1.9
expugno, ...	32.3	69.2	60.2	62.5	4.5	3.1	3.4	3.3	3.6
facile, ...	39.9	74.3	71.4	75.0	4.2	2.8	3.0	2.8	3.2
filia, ...	88.5	93.7	97.9	97.2	2.0	1.5	.8	1.0	1.3
flumen, ...	99.1	99.6	98.9	93.1	.3	.0	.4	1.6	.6
fortiter, ...	62.6	84.5	89.8	86.1	3.3	2.3	1.9	2.2	2.4
fossa, ...	82.3	96.8	75.5	66.7	2.4	1.1	2.8	3.2	2.4
frumentum, ..	94.4	99.2	97.9	95.8	1.4	.2	.8	1.3	.9
gladius, ...	73.9	85.3	88.7	88.9	2.9	2.3	2.0	2.0	2.3
incolo, ...	43.5	70.7	46.9	77.8	4.0	3.0	3.9	2.7	3.4
intellego, ...	42.1	78.7	94.9	91.7	4.1	2.6	1.4	1.7	2.5
interficio, ...	66.6	87.3	90.8	81.9	3.2	2.1	1.8	2.4	2.4
iste, ...	59.8	51.4	81.6	86.1	3.4	3.7	2.5	2.2	3.0
itaque, ...	53.1	92.5	97.9	94.4	3.7	1.7	.8	1.4	1.9
legatus, ...	84.6	93.7	87.7	94.4	2.3	1.5	2.1	1.4	1.8
legio, ...	78.4	87.3	66.3	62.2	2.6	2.1	3.2	3.3	2.8
liber, ...	84.0	68.0	82.6	87.4	2.3	3.1	2.4	2.1	2.5
liberi, ...	68.5	75.1	75.5	81.9	3.1	2.8	2.8	2.4	2.8
libero, ...	58.1	60.8	82.6	93.1	3.5	3.4	2.4	1.6	2.7
magis, ...	23.3	30.0	44.9	54.2	4.9	4.6	4.0	3.6	4.3
maxime, ...	36.5	39.0	50.0	41.7	4.3	4.2	3.8	4.1	4.1
minor, ...	59.3	56.9	56.1	79.2	3.5	3.6	3.6	2.7	3.4
minus, ...	33.7	49.4	61.2	62.5	4.5	3.8	3.4	3.3	3.8
mons, ...	86.5	91.3	87.7	87.4	2.2	1.8	2.1	2.1	2.1
moror, ...	34.0	48.6	39.8	80.6	4.4	3.9	4.2	2.5	3.8
multitudo, ...	86.5	94.4	94.9	94.4	2.2	1.4	1.4	1.4	1.6
natura, ...	63.2	81.8	84.7	81.9	3.3	2.5	2.3	2.4	2.6
nolo, ...	45.8	60.1	65.3	66.7	4.0	3.4	3.2	3.2	3.5
numen, ...	1.4	3.5	10.2	50.0	7.1	6.5	5.7	3.8	5.8
obses, ...	46.6	61.3	65.3	66.7	3.9	3.4	3.2	3.2	3.4
oppidum, ...	94.7	98.4	95.9	94.4	1.4	.6	1.2	1.4	1.2
optimus, ...	60.7	59.3	68.3	75.0	3.4	3.5	3.1	2.8	3.2
passus, ...	51.7	53.3	52.0	47.2	3.7	3.7	3.7	3.9	3.8
persuadeo, ...	95.2	97.2	100.0	100.0	1.3	1.0	.0	.0	.6
pes, ...	66.6	77.1	81.6	83.3	3.2	2.7	2.5	2.4	2.7
plurimus, ...	58.7	51.8	62.2	59.7	3.5	3.7	3.3	3.4	3.5
plus, ...	58.1	57.7	77.5	81.9	3.5	3.5	2.7	2.4	3.0
pons, ...	76.7	96.4	98.9	98.6	2.7	1.1	.4	.5	1.2
porto, ...	75.8	73.1	81.6	90.3	2.8	2.9	2.5	1.9	2.5
prope, ...	24.1	50.2	65.3	77.8	4.8	3.8	3.2	2.7	3.6
provincia, ...	94.7	97.2	98.9	98.6	1.4	1.0	.4	.5	.8
proximus, ...	50.0	57.3	68.3	73.6	3.8	3.5	3.1	2.9	3.3
quidam, ...	42.4	26.1	45.9	37.5	4.1	4.7	4.0	4.3	4.3
quinque, ...	57.6	44.2	45.9	44.4	3.5	4.0	4.0	4.0	3.9
quo, ...	23.0	31.6	39.8	68.1	4.9	4.5	4.2	3.1	4.2
reliquus, ...	58.7	92.9	86.7	94.4	3.5	1.6	2.2	1.4	2.2
ripa, ...	62.1	75.5	59.2	73.6	3.3	2.8	3.5	2.9	3.1
septem, ...	90.7	95.7	98.9	100.0	1.8	1.3	.4	.0	.9
septimus, ...	67.7	81.0	86.7	93.1	3.1	2.5	2.2	1.6	2.6
sex, ...	88.2	95.7	95.9	91.7	2.0	1.3	1.2	1.7	1.6
silva, ...	89.6	97.2	97.9	97.2	1.9	1.0	.8	1.0	1.2
statim, ...	46.9	61.3	70.4	80.5	3.9	3.4	3.0	2.5	3.2
sub, ...	77.8	90.1	91.8	97.2	2.7	1.9	1.7	1.0	1.8
summus, ...	60.1	67.6	73.4	77.8	3.4	3.1	2.9	2.7	3.0
superior, ...	74.7	83.8	84.7	88.9	2.8	2.3	2.3	2.0	2.6
sustineo, ...	76.4	94.9	94.9	83.3	2.7	1.4	1.4	2.4	2.0
trans, ...	87.9	95.3	97.9	100.0	2.1	1.3	.8	.0	1.1
transeo, ...	65.2	91.7	97.9	98.6	3.2	1.7	.8	.5	1.6
ultimus, ...	29.2	37.2	61.2	76.4	4.6	4.3	3.4	2.7	3.8
uter, ...	21.9	22.5	28.6	40.3	5.0	4.9	4.6	4.2	4.7
vester, ...	44.4	42.3	87.7	81.9	4.0	4.1	2.1	2.4	3.2
viginti, ...	68.5	79.4	77.5	86.1	3.1	2.6	2.7	2.2	2.7
vulnero, ...	72.8	88.1	95.9	94.4	2.9	2.1	1.2	1.4	1.9
					258.8	215.2	196.5	183.7	214.7

P. E. the P. E. equivalents of the percentages of times it was correctly translated. Thus in Table II *acriter* was correctly translated by 47.7% of first year pupils. The P. E. equivalent found by consulting tables of P. E. values corresponding to given percents of the normal surface of frequency[2] is +.085 above the median. This value added to —3.8 P. E. gives 3.885 or 3.9, the assigned value. The same procedure was followed in determining the scale values for the other years. The derivation of the general scale value requires the determination of the size of the intervals between the medians of the successive years which, in turn, involves the amount and percentage of overlapping between the different years. Table III gives the facts.

TABLE III

NUMBER AND PERCENT. OF PUPILS REACHING OR EXCEEDING THE MEDIAN OF EVERY OTHER YEAR.

		I	II	III	IV
I	Number, ...		111	80	56
	Percent, ...		31.1	22.4	15.7
	P. E., ...		+ .731	+ 1.125	+ 1.493
II	Number, ...	185		100	64
	Percent, ...	73.1		39.5	25.3
	P. E., ...	— .913		+ .395	+ .986
III	Number, ...	76	60		40
	Percent, ...	77.5	61.2		40.8
	P. E., ...	— 1.120	— .422		+ .345
IV	Number, ...	63	49	41	
	Percent, ...	87.5	68.0	57.0	
	P. E., ...	— 1.706	— .693	— .261	

From this table were obtained the various direct and derived values of the intervals between the first year median and the other years. The method is given in the earlier papers and is not repeated here. The intervals between the years, using six direct and derived intervals and giving the direct intervals a weight of 6 and the derived intervals involving skipping of one or two steps, weights of 4 and 2, respectively, are as follows:

M_1—M_2	M_2—M_3	M_3—M_4
.775 P. E.	.394 P. E.	.374 P. E.

[2] BUCKINGHAM, B. R. *Spelling Ability—Its Measurement and Distribution*, 1913, p. 116.

When referred to the first year median, the intervals between it and the third and fourth years are:

M_1—M_3	M_1—M_4
1.169 P. E.	1.543 P. E.

The intervals between the various years thus being known, the general scale value is obtained by adding to the various P. E. values for each word the intervals at which the medians of each year stand above the first year, viz. .775, 1.169, 1.543. The average of the values thus obtained gives the average position of the word when referred to the first year median. To eliminate minus values the average position of the arbitrarily assumed zero point, when this is referred to the first year median by adding as before .775, 1.169, and 1.543 respectively, was obtained and taken as the point of reference. This average position is —2.947. The average position of each word when referred to this point of reference by subtraction from, or addition to it, gives the basis for the general scale value indicated in the Table.

This list of words is much less satisfactory for testing purposes than the vocabularies reported in the earlier study. A very considerable number of the words occur frequently in Caesar, but seldom, if ever, are they used in Cicero or Vergil. The result is that some of the words are translated correctly more frequently in the first or second years than in the third or fourth years. Notable examples are *fossa, flumen, legio,* and *passus.* Many words show such inversions in the third year. Moreover, few of the words, even if they do not show inversions, grade up at all uniformly.

It is interesting to note the difference between the year medians with this list and with the earlier list of 239 words. The difference between the first year and the second year by the earlier list was found to be 1.541 P. E. while by this list it is .775 P. E. The differences between the second and third and the third and fourth years by the earlier list were 1.281 P. E. and .465 P. E., while for the later list the intervals are .394 P. E. and .374 P. E. The greater variability in frequency of occurrence accounts for these differences.

Omitting from the list those words which are so easy as to be missed by third or fourth year pupils, such as *bene, persuadeo, septem* and *trans,* those where an English derivative makes the translation obvious, such as *animal, captivus, minor, minus,* and *multitudo,*

the numerals, and those words showing marked inversions or irregularities, there remains a list of 50 fairly satisfactory words. This list, which may be added as Test E to the four previously constructed, appears below with the words arranged in order of difficulty and with the corresponding scale values.

Latin Vocabulary Test E

silva	1.2	liberi	2.8
pons	1.2	summus	3.0
filia	1.3	plus	3.0
transeo	1.6	iste	3.0
legatus	1.8	celeriter	3.1
sub	1.8	ripa	3.1
equus	1.9	celeritas	3.2
vulnero	1.9	optimus	3.2
itaque	1.9	statim	3.2
sustineo	2.0	vester	3.2
mons	2.1	proximus	3.3
collis	2.2	obses	3.4
reliquus	2.2	nolo	3.5
gladius	2.3	plurimus	3.5
interficio	2.4	acriter	3.5
fortiter	2.4	prope	3.6
porto	2.5	expugno	3.6
intellego	2.5	ultimus	3.8
liber	2.5	moror	3.8
convoco	2.6	maxime	4.1
civitas	2.6	quo	4.2
septimus	2.6	magis	4.3
pes	2.7	quidam	4.3
amicitia	2.7	uter	4.7
libero	2.7		
cornu	2.7		140.7

Standard June scores with this test, in terms of the number correct, precents correct, and the sum of the scale values, would be as follows:

	I	II	III	IV
Number correct	29	35	38	40
Percents correct	58	70	76	80
Sum of scale values	77	91	101	108

SENTENCE TESTS

Sixty sentences, arranged in four sets of fifteen each, were selected or constructed, using in them none but words found in the list of 239 words common to vocabularies of high school Latin. The sentences were as follows:

Latin Sentence Test (1)

1. Eques fortis est .....
2. Dux filio telum dedit .....
3. Hi pueri exercitum hostium viderunt .....
4. Scimus ubi hae res sint .....
5. Copiae auxilio amicis missae sunt .....
6. In hoc loco castra ponere non possumus .....
7. Quorum adventu spes matri meae erit .....
8. Milites magna cum virtute urbem oppugnabant .....
9. Patrem fortiorem filio esse dicent .....
10. Hoc proelio facto copias in fines suos ducit.....
11. Hoc faciemus ut domum sine iniuria veniat .....
12. Eius frater veritus est ne opus difficilius esset .....
13. Si hostes vincant, fines nostros relinquamus et alias domos petamus .....
14. Eo cum venisset principes ad se duci iussit .....
15. Pacis faciendae causa homines ex his urbibus a senatu appellati erant .....

Latin Sentence Test (2)

1. Muri urbis alti erant .....
2. Amicus meus servos bonos habet .....
3. Miles tibi telum dabit .....
4. Dies tres exercitui praeerat .....
5. Tertio anno belli vincemus .....
6. Dixit se urbem oppugnaturum esse .....
7. Eques magno cum periculo ducis vitam defendit .....
8. Consul cum decem milibus equitum in fines hostium profectus est
9. Rogamus ut pax cum finitimis nostris sit .....
10. Nemo est qui pugnare quam pacem habere malit .....
11. Viam facimus quo facilius eos sequamur .....
12. In imperatore deligendo magna virtus petenda est .....
13. Res tuae ita secundae erant ut ab dis auxilium non peteres ....
14. Cum omnia incensa sint domi nihil est quo vitam tenere possint
15. Hoc consilium belli gerendi causa cum finitimis suis fecit .....

Latin Sentence Test (3)

1. Exercitus est magnus .....
2. Mors homines superat .....
3. Eum ire iussit .....
4. Undique pugnatum est .....
5. Bellum decem annos gesserant .....
6. Nihil erat reliqui .....
7. Prima luce proelium ab hostibus commissum est .....
8. Milites urbi auxilio erunt .....
9. Dixit se nuntium pacis fuisse .....
10. Nunc rogas quid facere possim .....
11. Equites contenderunt ut quam primum domum pervenirent ....
12. Si telum coniciat periculum sit .....
13. Vereor ne frater eius malus sit .....
14. Locus castris muniendis facilis nobis deligendus est .....
15. Si armis uti potuisset, non profectus esset .....

Latin Sentence Test (4)

1. Puer in agro est .....
2. Milites ex castris ducit .....
3. Eos tribus diebus in hoc loco videbimus .....
4. Urbs ab exercitu diu occupata est .....
5. Ad quem eius pater nuntium misit .....
6. Poteritne in eam partem urbis impetum facere? .....
7. Alii proelium relinquunt, alii magna cum virtute pugnant .....
8. Incendite domos vestras et iter nobiscum facite .....
9. His rebus cognitis, totus exercitus prima luce discesserunt ....
10. Multi undique venerunt ut pacem ab illo duce peterent .....
11. Equites tam celeres sunt ut nostri eos sequi non possint .....
12. Hoc bellum nobis maxima cum virtute gerendum est si vincere volumus .....
13. Nuntius profecturus, amicis de itinere nihil dixit .....
14. Urbs, quae eo tempore non munita est, facile capta est .....
15. Cui nos qui superati sumus arma nostra tradimus? .....

These sets, in whole or in part, were given in eleven schools, distributed in five states. Table IV gives the median scores in each test and the number of pupils taking them.

The same wide range of abilities as appeared in the vocabulary test is shown in translating these sentences.

SENTENCE TEST 1

SCHOOL	Medians				No. of Pupils			
	I	II	III	IV	I	II	III	IV
B	7				13			
D	4	6	6	7	34	33	17	11
E	1	3.5	7	9	30	8	3	3
F	3	6	9	10	44	35	19	9
I	6	3	9	9	47	27	7	6
J	3	7.5	9		18	14	3	1
K	5	8	12	10	13	21	8	11
L	0				4			
M	2	5			19	9		
N			14	12			13	5
O	5	5			13	5	2	
	4	6	9	10	235	152	72	46

SENTENCE TEST 2

SCHOOL	Medians				No. of Pupils			
	I	II	III	IV	I	II	III	IV
B		7	10	9		8	3	7
D	3	5	7	7	36	36	17	12
E	1	2.5	5	9	28	8	3	3
F	2	5	8	11	19	29	17	8
I	3	2	3.5	6.5	45	29	6	6
J	2	5.5	9		18	14	3	1
K	3	9	12	9	16	20	8	11
L	0				6			
M	1	1			19	9		
N			12	13			14	7
O		4				5	2	
	2	5	8	9	187	158	73	36

SENTENCE TEST 3

SCHOOL	Medians				No. of Pupils			
	I	II	III	IV	I	II	III	IV
B		8	9	7		6	3	6
E	2	5	5	7	26	8	3	3
F		8	9.5	10.5		15	12	4
I	4	4.5	7	7	49	26	7	7
J	2.5	5.5	7		18	14	3	1
K	3	8	10.5	9	17	21	8	11
L	1				5			
M	3	6			19	9		
N			12	11			15	7
O	5				13		2	
	3	7	10	10	147	99	53	39

SENTENCE TEST 4

SCHOOL	Medians				No. of Pupils			
	I	II	III	IV	I	II	III	IV
B			10	12.5			3	6
E	2	4	6	12	27	8	3	3
I	5	5	6	11.5	48	30	5	6
J	3	8	13		16	15	3	1
K	3.5	10	14	10	16	21	6	11
L	1				5			
M	3	6			19	9		
N				14				23
O					13		2	
	3	6	10	13	144	83	22	50

Table V gives the percents of times each sentence is translated correctly and the scale values derived.

In deriving the scale values for each year and the general scale value the same method was employed as was used in the case of the vocabularies. For the general scale value the intervals between the year medians were determined as before. The long, detailed tables necessary for this purpose are omitted and the procedure is not described again. The forty-four sentences scaled in the earlier study had been referred to the position of the easiest sentence instead of the average position of 3.8 P. E., the arbitrarily assumed zero-point of ability in Latin. In order to refer the vocabularies and

TABLE V

Sentence Test		Percents Correct				Scale Values				General Scale
		I	II	III	IV	I	II	III	IV	
I	1	45.1	52.6	79.1	73.9	4.0	3.7	2.6	2.9	3.3
	2	57.0	66.5	83.3	87.0	3.5	3.2	2.4	2.1	2.8
	3	51.5	65.8	81.9	80.4	3.7	3.2	2.4	2.5	3.0
	4	29.4	32.2	80.2	89.1	4.6	4.5	2.5	2.0	3.4
	5	25.5	42.1	61.1	56.5	4.8	4.1	3.4	3.6	4.0
	6	54.9	69.1	88.9	97.8	3.6	3.1	2.0	.8	2.4
	7	3.4	22.4	59.7	60.9	6.5	4.9	3.4	3.4	4.6
	8	70.6	79.6	79.1	80.4	3.0	2.6	2.6	2.5	2.7
	9	4.9	6.6	23.6	15.2	6.3	6.0	4.9	5.3	5.6
	10	16.2	66.5	59.7	60.9	5.3	3.2	3.4	3.4	3.8
	11	5.1	14.5	33.3	34.8	6.2	5.4	4.4	4.4	5.1
	12	2.1	11.8	33.3	23.9	6.8	5.6	4.4	4.9	5.4
	13	6.4	15.8	38.9	43.5	6.1	5.3	4.2	4.0	4.9
	14	.4	26.3	47.2	43.5	7.6	4.7	3.9	4.0	5.1
	15	1.7	26.3	59.7	50.0	6.9	4.7	3.4	3.8	4.7
						78.9	64.2	49.9	49.6	60.8
II	1	59.4	67.7	59.0	78.2	3.4	3.1	3.5	2.7	3.2
	2	47.1	62.7	79.5	72.7	3.9	3.3	2.6	2.9	3.2
	3	21.9	23.4	57.5	65.4	5.0	4.9	2.5	3.2	4.2
	4	31.0	46.8	50.7	63.6	4.5	3.9	3.8	3.3	3.9
	5	9.6	18.4	30.1	52.7	5.7	5.1	4.6	3.7	4.8
	6	16.6	40.5	63.0	63.6	5.2	4.2	3.3	3.3	4.0
	7	27.8	36.7	80.8	61.8	4.7	4.3	2.5	3.4	3.7
	8	13.9	49.4	63.0	61.8	5.4	3.8	3.3	3.4	4.0
	9	10.7	36.1	74.0	56.4	5.6	4.3	2.8	3.6	4.1
	10	5.3	36.1	72.6	78.2	6.2	4.3	2.9	2.7	4.0
	11	5.3	32.5	53.4	47.3	6.2	4.5	3.7	3.9	4.6
	12	.5	15.2	50.7	61.8	7.6	5.3	3.8	3.4	5.0
	13	.0	3.8	31.5	52.7	7.6	6.4	4.5	3.7	5.6
	14	.0	5.7	31.5	23.6	7.6	6.1	4.5	4.9	5.8
	15	5.3	22.2	50.7	47.3	6.2	4.9	3.8	3.9	4.7
						84.8	68.4	49.6	52.0	60.8
III	1	83.7	97.0	98.1	89.7	2.3	1.0	.7	1.9	1.5
	2	40.8	44.4	71.7	59.0	4.1	4.0	2.9	3.5	3.6
	3	23.8	65.7	90.6	89.7	4.9	3.2	1.8	1.9	3.0
	4	29.4	61.6	67.9	79.5	4.6	3.4	3.1	2.6	3.4
	5	51.7	72.7	88.7	74.4	3.7	2.9	2.0	2.8	2.9
	6	46.9	71.7	81.1	64.1	3.9	2.9	2.5	3.3	3.2
	7	23.8	74.7	81.1	71.8	4.9	2.8	2.5	2.9	3.3
	8	20.4	21.2	28.3	35.9	5.0	5.0	4.7	4.3	4.8
	9	12.9	27.3	67.9	64.1	5.5	4.7	3.1	3.3	4.2
	10	2.0	13.1	66.0	56.4	6.8	5.5	3.2	3.6	4.8
	11	.0	25.3	45.3	38.5	7.6	4.8	4.0	4.2	5.2
	12	5.4	36.4	71.7	74.4	6.2	4.3	2.9	2.8	4.1
	13	6.1	20.2	66.0	74.4	6.1	5.0	3.2	2.8	4.3
	14	.0	2.0	13.2	17.9	7.6	6.8	5.5	5.2	6.2
	15	4.1	10.1	50.9	56.4	6.4	5.7	3.8	3.6	4.9
						79.6	62.0	56.0	48.7	64.5
IV	1	94.4	96.4	95.4	100.0	1.4	1.1	1.3	.0	1.0
	2	52.1	80.7	77.3	96.0	3.7	2.5	2.7	1.2	2.5
	3	31.3	37.4	63.6	92.0	4.5	4.3	3.3	1.7	3.5
	4	37.5	33.7	54.5	74.0	4.3	4.4	3.6	2.8	3.8
	5	16.7	29.0	63.6	74.0	5.2	4.6	3.3	2.8	4.0
	6	13.9	26.5	59.1	76.0	5.4	4.7	3.5	2.8	4.1
	7	24.3	47.0	90.9	92.0	4.8	3.9	1.8	1.7	3.1
	8	12.5	32.5	72.7	98.0	5.5	4.5	2.9	.8	3.4
	9	4.2	59.0	68.2	90.0	6.4	3.5	3.1	1.9	3.7
	10	13.2	43.4	59.1	86.0	5.5	4.0	3.5	2.2	3.8
	11	18.1	53.0	81.8	82.0	5.2	3.7	2.5	2.4	3.5
	12	11.1	32.5	59.1	94.0	5.6	4.5	3.5	1.5	3.8
	13	6.3	14.5	27.3	64.0	6.1	5.4	4.7	3.3	4.9
	14	29.8	65.0	77.3	86.0	4.6	3.2	2.7	2.2	3.2
	15	1.4	6.0	9.1	48.0	7.1	6.1	5.8	3.9	5.7
						75.3	60.4	48.2	31.2	54.0

all the sentences in this study and the earlier one to the same point, and thus make possible the arrangement of all the sentences together into alternative tests, the general scale values of the earlier study were redetermined by exactly the same method as was used with the words and referred to the same zero-point. The 104 sentences referred to this point were arranged in order of difficulty and thereupon grouped into 10 tests of approximately the same difficulty. The first test contains 12 sentences grading up by steps of .5 P. E. except the step between the eleventh and twelfth sentences. The remaining tests contain ten sentences each and are graduated by steps of .5, .4 or .2 P. E. with exceptions here and there to make the sum of the scale values or weights approximately equal. Tests 8 and 9 contain the 20 sentences remaining after the best arrangements for the other tests had been made.

The tests have been arranged in small groups in order that they may be given easily in any class period and the factor of speed has been avoided so far as possible. In giving the tests no time limit is therefore set. The sentences are scored as either right or wrong. No attmpt has been made to give fractional weights where a part of a sentence is correctly translated.

The ten tests, with the scale values for each sentence and their sum, and standard June scores in terms of the average number of sentences correct and the sums of the scale values for each of the four years of high school Latin, are as follows:

Sentence Test 1.

1. .5—Puer bonus est.
2. 1.0—Puer in agro est.
3. 1.5—Exercitus est magnus.
4. 2.0—Ubi sunt copiae hostium?
5. 2.5—Via erat longa et lata.
6. 3.0—Eum ire iussit.
7. 3.5—Equites tam celeres sunt ut nostri eos sequi non possint.
8. 4.0—Nemo est qui pugnare quam pacem habere malit.
9. 4.5—Cum in urbem venissem et ibi de principis fortuna bona certior factus essem, domum ivi.
10. 5.0—Dicere non possum quam diu pater meus in eo loco fuerit.
11. 5.5—Qui bonum cum potest non defendat non laudandus est.
12. 5.8—Cum omnia incensa sint domi nihil est quo vitam tenere possint.

38.8

	1	2	3	4
Average no. of sentences correct	5.3	6.4	8.1	9.5
Sum of scale values	9.8	14.0	21.8	28.3

Sentence Test 2

1. 1.7—Navis parva est.
2. 2.2—Sunt viri fortes.
3. 2.7—Milites magna cum virtute oppugnabant.
4. 3.2—Urbs, quae eo tempore non munita est, facile capta est.
5. 3.7—His rebus cognitis, totus exercitus prima luce discesserunt.
6. 4.2—Nuntius matri dixit filium noctu venturum esse.
7. 4.7—In eo loco ad multam noctam se defenderunt.
8. 5.2—Equites contenderunt ut quam primum domum pervenirent.
9. 5.7—Cui nos qui superati sumus arma nostra tradimus?
10. 6.2—Locus castris muniendis facilis nobis deligendus est.

39.5

	1	2	3	4
Average No. of sentences correct	3.9	5.6	6.0	7.0
Sum of scale values	10.5	18.1	22.5	24.2

Sentence Test 3.

1. 1.6—Homo malus est.
2. 2.7—Tuum fratrem non video.
3. 3.1—Alii proelium relinquunt, alii magna cum virtute pugnant.
4. 3.5—Eos tribus diebus in hoc loco videbimus.
5. 3.9—Dic mihi quid tibi in animo sit.
6. 4.3—Ille dux nomine sed non factis amicus erat.
7. 4.7—Pacis faciendae causa homines ex his urbibus a senatu appellati erant.
8. 5.1—Hoc faciemus ut domum sine iniuria veniat.
9. 5.5—Si imperator esses, daresne proeli committendi signum?
10. 5.6—Res tuae ita secundae erant ut ab dis auxilium non peteres.

40.0

	1	2	3	4
Average no. of sentences correct	3.0	3.8	6.1	7.0
Sum of scale values	7.5	16.3	21.6	25.5

Sentence Test 4.

1. 2.4—In hoc loco castra ponere non possumus.
2. 2.8—Dux filio telum dedit.
3. 3.2—Amicus meus servos bonos habet.
4. 3.4—Scimus ubi hae res sint.
5. 3.6—Equites urbem hostium magna cum virtute oppugnaverant.
6. 4.0—Copiae auxilio amicis missae sunt.
7. 4.4—Periculis multis in vita superatis mortem non timebit.
8. 4.8—Scit te saepe nomen imperatoris huius audivisse.
9. 5.1—Eo cum venisset principes ad se duci iussit.
10. 5.6—Alii alia dixerunt sed omnes eum magna virtute esse sciebant.

39.3

	1	2	3	4
Average no. of sentences correct	2.5	3.9	6.1	6.5
Sum of scale values	7.9	13.5	22.9	28.2

Sentence Test 5.

1. 2.5—Milites ex castris ducit.
2. 2.9—Bellum decem annos gesserant.
3. 3.3—Hi omnes magnae virtutis erant.
4. 3.5—Nihil novi de bello audivi quod non in urbe fui.
5. 3.7—Eques magno cum periculo ducis vitam defendit.
6. 4.1—Rogamus ut pax cum finitimis nostris sit.
7. 4.5—Navem post primam lucem non relinquebant.
8. 4.9—Nonne vereris ne omnem fortunam amittas.
9. 5.3—Centum naves corpora armaque quae post proelium in agris relicta erant contulerunt.
10. 5.6—Patrem fortiorem filio esse dicent.

40.3

	1	2	3	4
Average no. of sentences correct	1.8	3.5	5.9	5.9
Sum of scale values	6.0	12.1	22.2	23.8

Sentence Test 6.

1. 3.0—Pater vocat filium.
2. 3.2—Filia parva in periculo est.
3. 3.4—Undique pugnatum est.
4. 3.6—Mors homines superat.
5. 3.8—Hoc bellum nobis maxima cum virtute gerendum est si vincere volumus.
6. 4.0—Ad quem eius pater nuntium misit?
7. 4.2—Dux dicitur pervenisse.
8. 4.4—Este fortes, milites, et tela longissime conicite.
9. 4.6—Quorum adventu spes matri meae erit.
10. 4.8—Nunc rogas quid facere possim?

39.0

	1	2	3	4
Average no. of sentences correct	3.0	4.1	6.2	7.0
Sum of scale values	10.0	14.7	23.6	26.8

Sentence Test 7.

1. 3.1—Servum misit quem secum habebat.
2. 3.3—Prima luce proelium ab hostibus commissum est.
3. 3.6—Id dictu quam factu facilius est.
4. 3.7—Illi homines duos amicos habebant.
5. 3.9—Dies tres exercitui praeerat.
6. 4.1—Poteritne in eam urbis impetum facere?
7. 4.3—Vereor ne frater eius malus sit.
8. 4.6—Rogas cur proelium nunc relinquere velim.
9. 4.7—Hoc consilium belli gerendi causa cum finitimis suis fecit.
10. 4.9—Si armis uti potuisset, non profectus asset.

40.2

	1	2	3	4
Average no. of sentences correct	2.3	4.0	6.1	7.1
Sum of scale values	8.5	15.0	23.8	27.9

Sentence Test 8.

1. 3.0—Hi pueri exercitum hostium viderunt.
2. 3.2—Filius patris similis erit.
3. 3.4—Incendite domos vestras et iter nobiscum facite.
4. 3.8—Mors finis esse videtur.
5. 3.9—Cum miles fortiter in bello pugnavisset ad domum profectus est.
6. 4.1—Si telum coniciat periculum sit.
7. 4.3—Huic viro multi servi erunt.
8. 4.6—Auxilium mittet ne hostes urbem capiant.
9. 4.8—Tertio anno belli vincemus.
10. 5.0—In imperatore deligendo magna virtus petenda est.

40.1

	1	2	3	4
Average no. of sentences correct	2.8	3.7	5.9	6.8
Sum of scale values	10.1	14.1	22.7	26.5

Sentence Test 9.

1. 3.3—Muri urbis alti erant.
2. 3.8—Urbs ab exercitu diu occupata est.
3. 3.9—Dixit se dare quod peterent.
4. 4.0—Consul cum decem milibus equitum in fines hostium profectus est.
5. 4.2—Miles tibi telum dabit.
6. 4.6—Viam facimus quo facilius eos sequamur.
7. 4.6—Cur te in his periculis non defendisti?
8. 4.9—Castra consulum a nostris paucis diebus capientur.
9. 4.9—Nuntius profecturus, amicis de itinere nihil dixit.
10. 5.1—Velim fratrem tuum roges, ne nos relinquat.

43.3

	1	2	3	4
Average no. of sentences correct	1.7	3.0	5.0	6.2
Sum of scale values	6.5	12.3	21.3	26.4

Sentence Test 10.

1. 3.3—Amicus pueri nuntius erat.
2. 3.8—Hoc proelio facto copias in fines suos ducit.
3. 3.8—Multi undique venerunt ut pacem ab illo duce peterent.
4. 3.9—Haec urbs multo maior eo oppido erat.
5. 4.0—Dixit se urbem oppugnaturum esse.
6. 4.2—Dixit se nuntium pacis fuisse.
7. 4.6—Milites urbi auxilio erunt.
8. 4.9—Si hostes vincant, fines nostros relinquamus et alias domas petamus.
9. 5.0—Nihil habeo quod populo dem.
10. 5.4—Eius frater veritus est ne opus difficilius esset.

42.9

	1	2	3	4
Average no. of sentences correct	2.2	3.4	5.3	5.8
Sum of scale values	8.4	12.4	22.3	23.9

An examination of the scores will show that while the sums of the scale values do not differ greatly the tests vary somewhat in difficulty with the different years. For instance, Test 2 is relatively easy for the first and second years, but relatively difficult for the third and fourth years. Test 5 in the fourth year, Test 6 in the first year, and Test 8 in the first year show irregularities. The sentences have been tried out in a great variety of permutations and combinations to reduce these irregularities to a minimum.

This completes the study of Latin vocabularies and sentences which the writer expects to make. There are available 250 words scaled for testing purposes and 102 sentences. Further work is planned looking toward the development of tests of knowledge of construction and syntax using these standardized sentences as a basis therefor. Studies of vocabularies and sentences in French and German will be published in the near future.

The Rational Learning Test Applied to Eighty-one College Students

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In a recent preliminary report[1] the writer described in detail the method of a new rational learning experiment which promises to have considerable value as an intelligence test. It is the purpose of the present article to study more fully the test-value of this type of learning. Few intelligence tests have attempted to measure quantitatively the effectiveness of a continued reasoning process; because of the difficulty of method in such a complex process, the tests have almost entirely been confined at best to more or less disconnected judgments about different sorts of relationship. In many cases tests designed more or less definitely to measure mental ability of some sort, have stressed rapidity and accuracy in certain acts of skill or of comprehension and retention. The present test—if we may so designate it—measures accurately and easily, and with no more apparatus than a stop watch, a screen, some sheets of paper, all one's relevant responses in a reasoning and memory process to a definite, objective situation. By increasing or decreasing the number of associations required—the number of letters used—the test can be varied in difficulty from the simplest type of problem to one that cannot be mastered by anyone.[2]

Each subject (S) is tested individually in a quiet room. It is important that the experimenter or tester (E) is concealed behind a screen where what he writes and his facial expression cannot be seen by S. S is allowed to read carefully, twice, the following instructions:

> The letters A, B, C, D, E, F, G, H, I, and J are numbered in a random order from 1 to 10. I call out the letters in their order and you are to guess numbers for each letter till you get the correct one, when I say "Right!" Then I call out the next letter, and so on. This continues till you get each number right, the first guess, twice through the series in succession from A to J. Then you are through. *You must ask no questions*

[1] PETERSON, JOS. *Experiments in Rational Learning. Psychol. Rev.*, 1918, *25*, 443-467.

[2] If more than twenty-six letters are desired different two-letter combinations may be used, as AA, AB, AC.....BA, BB. BC.....CA, CB, CC, CD, etc.

> after the experiment starts, but are to use all the mental powers at your command. You will be judged by (1) the total time you take, (2) the number of errors made, or wrong guesses, every number you call out being a guess, and (3) the number of repetitions from A to J required. Ready!

E then calls out A, recording all S's guesses in order under this letter on the record sheet. When the correct letter for A is given, which at this stage depends wholly upon chance, B is called out; and so on to J, which can be guessed with certainty if S has kept his cues in mind and has been wide awake. This is the first series; other series are repeated until the stage of perfection is reached that is described in the instructions. The chance element gradually yields to rational control as the successive letters are called out. In subsequent series the rrors dcrease in proportion to S's mastery of the situation. While the reader is referred to the original article, already cited, for a full explanation of the details of the method, the following record of one subject's reactions is repeated here for convenience of reference (Table I):

The responses (errors) marked (†) are called *logical errors,* because they repeat numbers which have already been used for earlier letters of the series and could not, according to the conditions of the experiment, be correct. The responses marked with an asterisk (*) are *perseverative errors,* repeating numbers already guessed (wrongly) for the letter in question, before its correct number is found. These are the most serious errors. A reaction may thus receive three error-counts—one as an "unclassified error," one as a "logical error," and one as a perseverative error."

The scores of eighty-one college students have been correlated with scores made by these same students in the second half year of General Psychology. The students were in three different sections, all conducted by the writer in the University of Minnesota in the second half of the academic year, 1917-1918. Most of the students were sophomores. There were in these sections other students than those whose records are here reported, some of whom had been tested by a slightly different method, so that their results cannot be used here, and some of whom could not arrange an appropriate time for the tests. There was. however, no selection that would make for an unfair sampling.

TABLE I

RECORD OF MR. L. D., A SOPHOMORE STUDENT

Letters Numbers	A 9	B 6	C 2	D 10	E 8	F 1	G 5	H 4	I 7	J 3	ERRORS Unclassified	†	*	Total
First Series, ...	3 5 1 2 9	8 7 10 3 1 6	5 3 1 7 10 9† 4 2	5 7 10	8	7 5 4 1	10† 3 5	10† 3 1† 7 6† 9† 2† 7* 9†* 2†* 4	5† 3 7	3	35	10	3	48
Second Series, ..	2 6 8 4 1 9	6	10 9† 2	9† 7 10	7 9† 8	7 5 3 9† 1	7 3 5	5† 9† 7 5†* 7* 9†* 10† 6† 9†* 6†* 4	7	9† 10† 6† 8† 2† 1† 3	33	18	5	56
Third Series, ...	8 6 9	2 4 8 10 1 7 8* 6	10 1 8 6† 3 7 5 8* 6†* 5* 4 10* 2	10	7 5 3 1 8	1	7 3 4 2† 5	4	3 7	3	30	3	5	38
Fourth Series, ..	9	6	2	10	8	1	5	4	7	3	0	0	0	0
Fifth Series, ...	9	6	1 8 2	10	8	1	5	4	7	3	2	0	0	2
Sixth and seventh series correct														
U. C. Errors ...	11	12	23	4	6	7	8	20	3	6	100			
† Errors ...	0	0	4	1	1	1	2	15	1	6		31		
* Errors ...	0	1	4	0	0	0	0	8	0	0			13	
Totals, ...	11	13	31	5	7	8	10	43	4	12				144

Ten of the eighty-one persons whose records are here reported were kindly tested for the writer in the final rush near the end of the academic year by Miss Alice H. Sullivan, at the time a scholar in the Department of Psychology in the University of Minnesota, whose aid is here gratefully acknowledged. As Miss Sullivan had previously tested but a few individuals by this method, it is probable that this irregularity slightly reduces the reliability of the tests. Of the special cases discussed in subsequent pages, the one marked "b" in Table II was tested by Miss Sullivan.

The scores in psychology are the average scores made in six short, technical examinations. Grades made in other subjects were not used because the writer had no evidence that the grading of papers had been done accurately enough for our present purpose. It is well known that most instructors make the grading of papers a most unscientific procedure.

A brief statement of the method used in securing and grading the psychology examination papers is here *a propos*. The method was not devised simply for this test, but has been used by the writer, with but slight modifications, for seven or eight years. Each examination has a definite time limit, which is so short that no student, with rare exceptions, gets through before time is called. The time in different examinations is not constant, as there is no reason for believing that all of the examinations are of exactly equal difficulty. There are enough questions given each time so that students will be kept busy without great elaboration on any one point and the students are instructed to be definite and brief. The writer believes that an examination which the best students can complete in less than the allotted time is not fair to such students; that it does not make the differences among the members of a class that actually exist. It is impossible in advance, moreover, to say, just what maximum values should be given each question, no two being equally difficult. To make up for this lack of accuracy in evaluating the several questions, it has been found best to make each question call for definite facts, for a specified number of reasons for or against a certain theory, or for points favoring or contradicting given interpretations of the results of an experiment; and also to assign, and to indicate with the questions, a maximum point-value to each question. Students can then see in advance just how to distribute their effort for the greatest number of points possible

to each according to his preparation. A maximum of thirty points is possible in any one examination. It is necessary to have this total constant, so that whenever any student happens to be absent from an examination his average can simply be found without any weighting.[3] The examinations are not announced in advance, so students are not aware, except as they are able to guess, when a written test will be given.

To keep effort high throughout the course, papers are, with rare exceptions, returned at the next meeting of the class, each paper bearing the scores given each answer, the total score, and the rank in the class or section. The rank is, of course, based on the total score. By this means each student knows his own weaknesses and also just how he ranks in the class. While the returned papers are in the hands of the students, the instructor reads the questions in order and answers each in a few definite statements. This not only gives additional assurance against error in assigning and adding up scores, but it also helps each student get any wrong idea corrected as soon as possible—an important element in any learning process. The papers of the examinations in question were all graded by a graduate student, a scholar in the department, who was not acquainted with the students, a man who had had considerable experience reading papers for the instructor (the writer). The reading of the papers was, however, carefully supervised by the instructor, who wrote out with each set of questions the sort of answers that would be acceptable. Part credit was allowed whenever the answer had a degree of value but not full value.

This method has been found by the writer to stimulate a high degree of effort on the part of students. It arouses wholesome competition, each student knowing that he can advance in rank only by surpassing some one else in the class; and that at the end of the course, only approximately 5% of the students—those with the

[3]Here there is a source of error that the writer has not fully overcome in a practicable manner. The average number of points made by the class in the several examinations is not a constant: that is, some examinations are found to be slightly easier than others. The time allowed usually varies from twenty to thirty minutes, being longer for harder questions. The three sections of students in this study did not take the same examinations, either: two sections meeting in successive hours had the same examinations and one section had a different examination. Here, then, are two factors slightly working against an exact ranking of the students in the psychology examinations. They will lower our correlation somewhat, as will also, probably, the fact mentioned in the second preceding paragraph.

best scores—will receive grade "A"; the next 20%, "B"; the middle half, "C"; the 20% below these, "D"; and that the lowest 5%, approximately, will be conditioned or get a failure in the course.

This is the method by which the scores in psychology used in the correlations below were obtained, a method, it is admitted, that lacks perfection in many respects. The work in the courses was not as mechanical as this statement might imply. The instructor soon because personally acquainted with all the students, and tried to get as close individual contact with each of them as possible. The final grades for the work of the course were determined in part by the students' reports on experiments and on other written work. The correlations here determined, however, are based *only on the average number of points made in the six short, technical examinations;* because these data are regarded as most reliable and most indicative of the student's ability. These psychology scores are correlated

Psych. / R. L. →	8-8.9	9-9.9	10-10.9	11-11.9	12-12.9	13-13.9	14-14.9	15-15.9	16-16.9	17-17.9	18-18.9	19-19.9	20-20.9	21-21.9	22-22.9	23-23.9	Freq.
20-99		(11a)				1	1	1(X)		X		1			1	O	8
100-179				1	IIII	III	1	II O	1	X II				1	II	1	19
180-259			1	II	II O	II	III O	X		O	III O	1		O			19
260-339		II	1	O	III	X				1		O			O		10
340-419			1		1	1	X	1		II	1						8
420-499		(O)		1		1	X		O				O				4
500-579			O	1	1			X	1				1				4
580-659							1		X			1					2
600-739		(·)				X											1
740-819		1			X				1								2
820-899															X 1		1
900-979		X															1
980-1059																	0
1060-1139																	0
1140-1219	O	X	1														2
Freq.	1	7	4	5	11	10	8	4	3	7	5	5	2	3	4	2	81

TABLE II

Showing the Distribution of 81 College Students on The Basis of The Average Score in Six Examinations in General Psychology and of Fewness of Errors in the Rational Learning Test. Circles Indicatee Approximate Means of Columns and Crosses those of Rows. The Circle and the Cross in Broken Lines Show the Means of Their Respective Column and Row When the Two Cases Marked "a" Are Omitted.

(inversely) with the total number of errors made in the rational learning test that is, with the unclassified errors *plus* the logical errors *plus* the perseverative errors, as described and illustrated

above. This score was found to be more significant than the time taken to complete the test or then the number of series required to fix the numbers, or than either of these three kinds of errors by themselves.

Results

The correspondence between the point-scores made in psychology and the fewness of errors in the rational learning test is shown in general in Table II. Each individual mark in the rectangles formed by the crossing of columns and rows indicates the position of one person as determined by both tests. Thus the two marks near the upper left hand corner of the table, marked "a", show that two students getting only an average of from 9 to 9.9 points in the psychology examination made but from 20 to 99 errors in the rational learning test. The mark in the upper right hand corner of the table indicates a student ranking among the best in both tests, while the one in the lower left corner is for a student that was the poorest in psychology, making an average score of only 8 to 8.9 points, and one of the two poorest in the rational learning. The records of the individual scores show that she was actually the poorest also in the rational learning, making a total of 1160 errors.

The heavy circles and crosses in the table mark the approximate means of the columns and rows, respectively. If a smoothed line be drawn through the crosses it will show the changes that take place in the x-values (right and left) as we go up the table from many to few errors in the rational learning. On the other hand, a similar smoothed line through the circles will show the regression line of the columns, or the changes that occur in the y-values with changes (to the right in the table) to better and better scores in psychology, or in x-values.

The table at once makes two important points clear. In the first place the two sets of relationships described in the foregoing paragraph are not in mutual agreement; that is, the regression of the x-values on y is not equal to the regression of the y-values on x. There is a pretty general and constant tendency to increase, though not to increase equally, in the x-values (points in psychology) with increases in the y-values (*i. e.*, with decreases in the number of errors in rational learning); but there is *not* such a constant tendency for the y-values to increase with increase in the x-values.

In more easily comprehensible terms, decrease in errors in rational learning seems in general to mean increase (though in a lesser degree) in scores in psychology, while increase in scores in psychology is not so constantly or so regularly accomplished by decrease in errors in the rational learning. The rational learning scores are probably more indicative of the student's ability than are the psychology scores, for the rational learning test was given once only and lasted but a short time, during which the subject as a rule applied his best effort; but a good record in psychology was dependent, within certain limits, not only on ability, but also to a considerable extent on such contingencies as health, the state at each test of having or not having reviewed well, having been free from disturbances in one's study, etc. It is evident that a student with but fair ability in the rational learning, by extra energy and application and precaution to review before each recitation, *can* make a good score in the examinations, while one with very good ability *may* on account of illness, eye trouble, or interference with study by the visit of relatives or friends or by social distractions, make a poor score in psychology. The rational learning test, therefore, seems to show more accurately what one can do in psychology, than what one influenced by all these factors actually will do.[4]

While correlations and regression lines show only general tendencies, and one must be careful not to yield too much to the temptation of "interpreting" exceptional cases, it may be said here, as an illustration of the various conditions affecting the psychology score, that the two individuals marked "a" in the distribution table are persons who made poor records in examinations because of lack of study. The one is a girl who admitted when she took the rational learning test and surprised the instructor by her efficiency that she had not studied her psychology. She said that she was economically independent and didn't "need to prepare for anything." Knowing of this attitude during the last month of the course, the instructor thereafter found it possible to interest her in certain phases of abnormal psychology; but this was too late to raise materially her average score in the examinations. The other person in this rectangle is a girl of exceptionally good ability, as it appears both from the test

[4]Ruml distinguishes between accidental and constant errors in school grades, and, somewhat in conformity with our findings even when grades were given with the greatest of care, says: "....the use of grades as a criterion of academic ability is open to serious objections." *Psychol. Monog.*, No. 105, p. 6.

and from later conversations, who was being treated for serious eye-trouble. She was not permitted by her physician to use her eyes in study. Both of these students had fallen seriously behind with their laboratory work, on which the examinations were partly based; and the one with the eye-trouble was necessarily rather irregular.

The case marked "b" in the table was a mature woman, who was taking only the one course in the University and was putting an excessive amount of time on it. She took the competition seriously. It was, however, a surprise to the instructor that she fell so low in the rational learning test. He regarded her as considerably above average in intelligence. Her attitude was, however, too subjective. The student at the lower left corner of the table, while she was studious and serious-minded, was considered the dullest in the class, though more mature in years than most of the members. The five students in the four upper right hand squares had, from all evidences available, very superior ability, and their attainment in the rational learning was no surprise to the instructor.

The second important fact revealed in Table II is one already indicated in other words, namely, that the regression line of y-values is non-linear. We note, as we go toward the right of the table—increase in the x-values,—first a very sudden increase in the y-values, one that would be more evident if the two cases marked "a", already discussed, were rightly placed in the psychological examinations, so that the mean of the second column would be lowered considerably; and then, until the last column is reached, no regular tendency to change with the increase of x-values. It seems that after a certain ability in the rational learning has been reached, further increases in this kind of ability or abilities is not necessary for the making of a fair or even a high standing in psychology, such standing depending on various other factors such as already noted. Exceptionally high scores in psychology, however, may be possible in general only to exceptional ability to cope with the rational learning test.

We must not forget here that college students generally are survivals of an elimination process in the grades and in the high school. The differences in their abilities are therefore not as great, relatively speaking, as is generally true of adults, though their interests may be as various. If we had a thousand unselected adults

prepared as well for psychology as their abilities would permit with the years of training that a sophomore has received, it is probable that the correlation in our table would be much higher, that the individual tallies would be found more nearly in a straight line reaching from the lower left to the upper right hand corner; for more cases of comparatively poor standing in the rational learning would pull down considerably the scores at the left two-thirds of the table. In other words, we are here dealing with a highly selected group of individuals and hence get non-linear regression of the values most indicative of ability, and only fair correlation by the usual methods of calculation. The product-moment formula of Pearson gives a correlation of only .33±.07 of psychology scores with fewness of errors in the rational learning test. Omitting the two cases at the upper left hand corner of the table, already discussed, we get r=.45±.06. Worked out by the tabular method illustrated by Rugg,[5] we get with the 81 cases r=.23±.07. By this method, of course, there are a number of slight displacements from the true position of persons nearly equal in ability, displacements that result from calling equal all those that fall within one column or row. Such displacement from the true position tends to lower the correlation; this is the explanation of the lower correlation by the tabular method.

Correlation Ratio

It is evident from the non-linearity of the means of the columns that we cannot in this study apply the formulæ for correlation that are usually used, formulæ that apply only to linear regressions. If we apply to the scores as distributed in our table, the formula for the correlation ratio, $\eta = \frac{\sqrt{\frac{S[n_x (y_x - y)^2]}{N}}}{\sigma_y}$, we get a correlation of .63±.04, which is rather high for a selected group of the kind here considered.[6]

[5] *Statistical Methods Applied to Education*, p. 264.

[6] According to Blakeman a correlation table may be regarded as exhibiting non-linear regression if $\frac{\sqrt{N}}{.67449} \cdot \frac{1}{2} \sqrt{\eta^2 - r^2} = 2.5$, or more. We are therefore safe in assuming non-linear regression in this case, for the value of this expression is 3.93. For the significance of each of the letters in this equation and in that for the correlation ratio, see Rugg, *op. cit.*, 278 ff.

If the rational learning test had been made harder for this group of students, by the use of a larger number of letters and therefore of the associations to be established, it is probable that a better distribution of abilities would have been made by this test. However, we must be careful regarding such an assumption, for a marked increase in the number of letters has seemed in other tests by the writer to throw too much emphasis relatively on mere rote memory and therefore not to give sufficient room for the better forms of rationalization pointed out in our earlier article. It is probably this organized ability, particularly, that is most indicative of intelligence.

Our correlation is hardly comparable with correlations obtained by other investigators between school standing and intelligence tests, because our scholastic standing was obtained in but one subject and by a method somewhat different from that commonly used. Terman found a correlation of .45 between the intelligence quotients of 504 children and their school work as judged by their teachers.[7] King and McCrory correlated the ratings by various tests on freshmen entering the College of Liberal Arts, University of Iowa, with their freshmen grades. There were 276 women and 268 men tested. These correlations were obtained:

	Women	*Men*
University grades with Opposites test.	.45	.84
Completion test.	.22	.41
Logical Memory test, ...	.35	.40
Analogies test, ...	.14	.40
Range of Information test,	.41	.44

In a different opposites test on 56 engineer freshmen, King got a correlation coefficient of but .26 with scholastic standing, while at Beloit College K. T. Waugh got a correlation with class standing of .84.[8] F. O. Smith, tracing the records of 120 students of the College of Liberal Arts of the University of Iowa, got a correlation of only .48 between high school average and university freshman average, making it obvious that very high correlations with scholastic standing cannot be expected.[9] In a recent study by Marie Hackl

[7] *The Stanford Revision and Extension of the Binet-Simon Scale for Measuring Intelligence*, 1917, 105 ff.

[8] See KING, I. AND MCCRORY, J., *Freshmen Tests at the State University of Iowa.* Jour. Ed. Psychol., 1918, *9*, 32-46.

[9] *A Rational Basis for Determining Fitness for College Entrance.* University of Iowa Studies in Education. N. S. 51, 1912.

Means a correlation of .54±.08 was obtained between the ratings by an opposites test of one hundred words given orally and individually to 73 students and the ratings in psychology on the basis of fourteen tests. The psychology class was conducted by Dr. E. K. Strong, Jr., in George Peabody College for Teachers. In this case the scholastic rating is made by a method much like our own.[10]

Experiments are now in progress by which we hope to compare ratings by the rational learning test with ratings by the Terman revision of Binet-Simon tests. The median time for giving the former test to college students under the conditions of the study here reported was only sixteen minutes, and the test can be given with almost absolute objectivity by any one who understands the technique and who has had but a small amount of practice. Its value lies not simply in being—as it seems— a fair intelligence test, but it also gives promise, as was shown in the earlier report, of being a means of classifying the subjects tested into two or three rather well-marked groups with reference to their attitudes—the subjective or self-conscious, the objective rational, and the objective trial and error. The first two of these groups correspond to Ruger's self-conscious attitude and problem attitude, respectively.

Suggestions for Giving the Rational Learning Test

In giving the rational learning test the experimenter should select a room free from distraction, and should have a stop watch (though this is not an essential), a screen to put up between himself and the subject, a copy of the instruction sheet, and some sheets of paper. While the subject, S, is reading the instructions, the experimenter, E, prepares the test-sheet heading as follows:

A B C D E F G H I J
9 6 2 10 8 1 5 4 7 3 Total E, Log. E, Per. E

He also records in the upper right hand corner of the sheet S's name, grade, and any other information or remarks desired, as well as the date and, if he has not a stop watch, the exact time of starting the experiment. Besides recording in order S's responses, or guesses, for each letter as explained and illustrated in the foregoing pages and more fully in the previous article already cited, E should also devise symbols of his own for recording various secondary responses, such as apparent doubt or certainty in S's mind as to his guess,

[10] *A Tentative Standardization of A Hard Opposites Test,* to be published.

length of hesitation, retraction of number guessed (though it is retained in the record as already explained), and the various squirmings, complaints, excuses and questions of some subjects. The length of hesitation at any one point can easily be indicated by putting a dot for approximately each second. To all questions and excuses E must, of course, remain silent, but he can easily indicate them for the interpretation of results. The errors are to be classified and counted up at E's leisure.

E's relation to S in the course of the test is such as to afford an unusual insight into the latter's mental make-up. The writer was once greatly interested in this aspect of the testing when he had a rather garrulous subject of about fifty years of age, who continuously raved and charged himself with all sorts of mental deficinecy, of which he now had objective proof, even to being, as he had often supposed, "an imbecile." This was an extreme case of a person who had fallen into the bad habit of avoiding real difficulties by circumlocution. The writer, as his instructor, had frequently called S's attention to this semi-pathological tendency and had made suggestions for its correction, but to little effect because of the seniority of S. Now the test afforded an excellent illustration of the futility of such behavior, in fact of its hindrance to the efficient mastery of the problem at hand, and of the need of getting right at the essentials of the situation. S had to stick to the problem to its finish as indicated in the instructions, and the lesson had a good effect.

Rational Learning Norms for College Students

Table III gives in a condensed form the tentative norms of rational learning, derived from the eighty-one college students whose records we have considered in the foregoing pages. The results are arranged in percentile tables. No attempt has been made to separate the sexes, as there were only seventeen men in the group, due to war conditions. Percentiles are given for each class of errors separately as well as for all together; also for the number of minutes required to master the problem, and the number of repetitions through the series, including the last two without errors. The hundredth percentile is simply the best record. The tenth to the ninetieth percentiles were accurately determined by considering the distribution to be a continuous series and taking the exact point in